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Preparatory Studies for Eco-design Requirements of EuPs

Lot 19: Domestic lighting - Part 2
Directional lamps and household luminaires

Final Task Report
Task 2: Economic and Market Analysis

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Important note:
This report contains the final results of research by the authors and is not to be perceived as the opinion of the European Commission.

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0 PREFACE

VITO and its partners are performing the preparatory study for the eco-design directive for Energy Using Products (EuP) related to domestic lighting, on behalf of the European Commission (more info http://ec.europa.eu/enterprise/eco_design/index_en.htm).

The environmental impacts of Energy-using Products such as those used in domestic lighting take various forms, including: energy consumption and the related negative contribution to climate change, consumption of materials and natural resources, waste generation and release of hazardous substances. Eco-design, which means the integration of environmental considerations at the design phase, is arguably the best way to improve the environmental performance of products.

The creation of a coherent framework for environmental product policy avoids the adoption of uncoordinated measures that could lead to an overall negative result; for example eliminating a toxic substance from a product, such as mercury from lamps, might lead to increased energy consumption, which could in total have a negative impact on the environment. A Community framework also ensures that divergent national or regional measures, which could hinder the free movement of products and reduce the competitiveness of businesses, are not taken. It is not the intention to decrease the quality of domestic lighting.

You can follow the progress of our study and find general information related to lot 19 on the project website when you register as stakeholder: http://www.eup4light.net
Please, also consult the website for timing and organisation of the tasks.

This report includes results concerning part 2 of the study concerning DLS (reflector lamps).

Important remark:
It must be clearly stated that this part 2 of the study relies on the draft regulation resulting from part 1 of the study on non-directional light sources. Specific items on non directional lamps that were discussed in part 1 will not be repeated in this part 2. Items that are related to all light sources can be repeated, only to improve the readability, not for new discussion.

1 PRODUCT DEFINITION

For more info see website www.eup4light.net.

2 ECONOMIC AND MARKET ANALYSIS

The aims of the economic and market analysis are:

- to place the product group "domestic lighting" within the total of EU industry and trade policy (see 2.1),
- to provide market and cost inputs for the assessment of EU-27 environmental impact of the product group (see 2.2),
- to provide insight into the latest market trends so as to indicate the place of possible eco-design measures in the context of the market-structures and ongoing trends in product design (see 2.3), and
- to provide a practical data set of prices and rates for the Life Cycle Cost calculation (LCC) (see 2.4).

2.1 Generic economic data

2.1.1 Definition of 'Generic economic data' and data sourcing

"Generic economic data" gives an overview of production and trade data as reported in the official EU statistics. It places domestic lighting products within the total of EU industry and trade and also enables to check whether the product complies with the eligibility criterion of Art. 15., par. 2, sub a, of the EuP Directive:

> "*The EuP [to be covered by an implementing measure] shall represent a significant volume of sales and trade, indicatively more than 200,000 units a year within the Community according to more recently available figures.*"

To investigate the volume of sales and trade of a product group, it makes sense to rely on Eurostat's product-specific statistics. For trade and production figures, these are the so-called Europroms[1]-Prodcom statistics.

Although the aim is to take into account the specific attributes of the Member States' national lighting markets, much of the analysis could only be performed at the level of the EU total lighting market or regions of EU, as data were only available for few years and only in an aggregated form. The comparisons of imports, exports, production and apparent consumption[2] give an impression of the relative scales within the total lighting market but for numerous reasons[3] the comparisons must

[1] Europroms is the name given to published Prodcom data. It differs from Prodcom in that it combines production data from Prodcom with import and export data from the Foreign Trade database.

[2] "Apparent consumption" is the estimation of the yearly consumption for each product based on the amount produced plus the amount imported minus the amount exported. This is the rationale for combining Prodcom and Foreign Trade data in Europroms (Eurostat Data Shop Handbook, part 6.4.2 Europroms-Prodcom data, version 29/08/2003).

[3] The general advantages, flaws and limitations of these official EU statistics are extensively discussed in i) the MEEUP Methodology Report and ii) the Eurostat data shop Handbook (part 6.4.2.) Europroms-Prodcom data, version 29/08/2003.

be considered only as approximations. The required data for all lamps (in both physical volume and in money units) is expressed by:

Apparent EU-27 consumption = Production + Imports – Exports

2.1.2 Generic data on lamp sales

At present, the main relevant domestic lamp types[4] are: GLS lamps, halogen lamps, linear fluorescent and compact fluorescent lamps. New lamp types like LED (Light Emitting Diode, at present with no Prodcom code available) and metal halide are relevant as new technologies and are treated as improvement options in the study (see chapter 7). Table 2.1 shows the relevant DLS categories in Eurostat.

Table 2.1: Prodcom segmentation for domestic Lamps

PRODCOM Code	DESCRIPTION
31.50.12.93	Halogen lamps : HL-MV, HL-MV-R
31.50.12.95	Halogen lamps : HL-LV, HL-LV-R
31.50.13.00	GLS lamps : GLS-F, GLS-C, GLS-R
31.50.15.30	Compact fluorescent lamps: CFLi + CFLi-R and nearly not domestic used CFLni + CFLni-R

The market data in physical volume and monetary units were retrieved for these product categories from the Eurostat[5] for EU-27 trade[6] and production for the years 2003-2007. Results including the calculated apparent consumption are presented in Figure 2.1.

Figure 2.1 shows that for EU-27:

- Over the past two years, the apparent consumption of GLS lamps has fluctuated (the production data for 2007 in Prodcom seems to be an estimate which is assumed to be around 250 million too high)..
- Apparent consumption of HL-MV and HL-LV was both around 300 million/year. A substantial part of these lamps is sold in the commercial sector. Table 2.5 shows a large increase in ELC sales from 2004-2008 for HL-LV and even more for HL-MV. Several countries also report that their domestic stock of HL has considerably increased during the past few years, e.g. Denmark where the halogen part of the stock increased from 15% in 2000 to 29% in 2006. For 2006, the contribution of halogen lamps increased to 31% of the stock in Germany and 24% for EU-27. Eurostat data do not seem to include all halogen sales, maybe because sales of multiple packs (2, 3 or even 8 lamps per pack) are counted as 1 lamp and lamp sales along with luminaires are missing.
- There has been a 434% increase in the apparent consumption of CFL (CFLi+CFLi-R+ +CFLni+CFLni-R) from 145 million in 2003, 177 million in 2004, 241 million in 2005, a dramatic increase to 426 million in 2006 and finally 630 million in 2007 (confirmed update by Nov. 2008 which was mentioned in the text of the report for part 1 of the study). A considerable part of these lamps are CFLi used in the domestic sector (see details in the end of 2.2.2).
- EU-27 net-export GLS and LFL and net-import of HL and CFL (CFLi+CFLni).

[4] See chapter 1 for an overview of lamp types, names and codes.
[5] http://epp.eurostat.ec.europa.eu (Theme "Industry, trade and services", last consulted 06/08/2008)
[6] In this study the focus is trade leaving and entering the EU-27 - Eurostat also includes data per EU country.

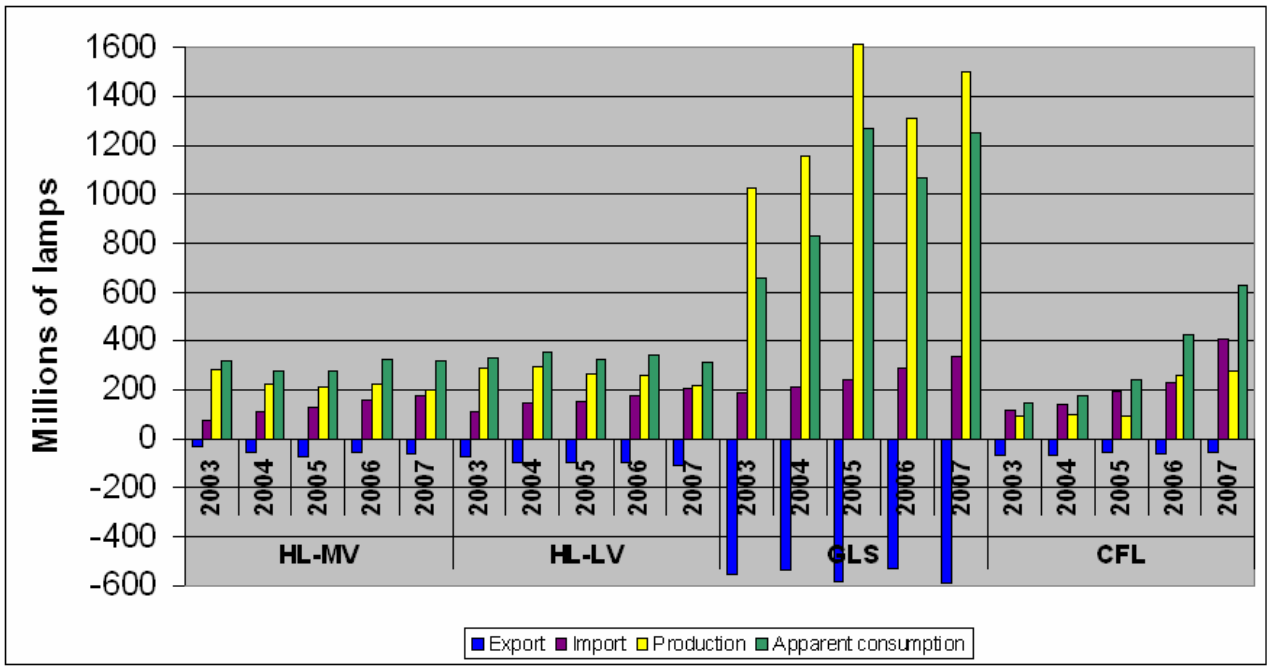

Figure 2.1: Volume of production, trade and sales of lamps for EU-27

The above Eurostat data include lamps in all sectors and thus not only domestic lighting application. In section 2.2, the use of different lamps in lighting is examined in more detail.

The Eurostat data might not include all lamps because:

- Some lamps are often sold in multipacks that could have been counted as 'one' unit in Eurostat. This could be the case for reflector lamps like HL-MV with G9, GU10 or R7s caps.
- Many luminaires for domestic lighting are sold with lamps that might not be counted in.

Product trends can also influence the data, such as the recent shift toward “double life” incandescent lamps, which have a lifetime 2000 hours. Unit sales will decline as the installed base extends its operating hours.

For a comparison of the economical value of export and production as well as import and apparent consumption please see part 1 of this study.

2.1.3 Generic data on luminaire sales

Table 2.2 shows the relevant luminaire categories in Prodcom (Eurostat).

Table 2.2: Prodcom segmentation for domestic luminaires

PRODCOM Code	DESCRIPTION
31502200	Electric table, desk, bedside or floor standing lamps
31502203	Domestic and residential luminaires (excl. spots): for incandescent lamps
31502205	Domestic and residential luminaires (excl. spots): for discharge lamps
31502209	Domestic and residential luminaires (excl. spots): for other lamps
31502530	Chandeliers and other electric ceiling or wall lighting fittings (excl. those used for lighting public open spaces or thoroughfares)
31502531	Luminaires for domestic and residential (excl. spots): for incandescent lamps
31502532	Luminaires for domestic and residential (excl. spots): for halogen lamps
31502533	Luminaires for domestic and residential (excl. spots): for compact fluorescent lamps
31502534	Luminaires for domestic and residential (excl. spots): for other lamps
31502547	Spots, display lighting: for incandescent lamps
31502548	Spots, display lighting: for other lamps
31502579	Other lighting fixtures: luminaires (interior), n.e.c.
31503430	Electric lamps and lighting fittings, of plastic and other materials, of a kind used for filament lamps and tubular fluorescent lamps
31503435	Exterior luminaires for houses and gardens : for incandescent lamps
31503437	Exterior luminaires for houses and gardens : for other lamps
31504250	Parts (excl. of glass or plastics) of lamps and lighting fittings, etc.

The categorisation in Table 2.2 is quite differentiated but the current luminaire data available in Eurostat are very limited as shown in Table 2.3.

Table 2.3: Prodcom luminaire production data available

PRODCOM Code	2004	2005	2006	2007
31502200 Table, desk, bedside or floor-standing lamps	26,000,000	19,971,309	21,936,702	22,004,961
31502530 Chandeliers + other ceiling or wall fittings	337,368,722	616,858,778	318,001,780	324,058,556
31503430 Lamps+fittings (filament+tubular fluorescent)	81,857,235	71,742,161	66,428,725	78,804,115
Total	445,225,957	708,572,248	406,367,207	424,867,632
Sales/household in case all production was sold in EU27 ')	2.1	3.4	1.9	2.0

') There are also sales in non-domestic settings but this assumed to be compensated by the imports that are missing

Remarks on Eurostat luminaire sales:

- All data in the table only include production, as export and import are not available;
- Data in the red fields with red shading is evaluated to be wrong probably because the sales in the category 31502530 are doubled;
- Only three categories include data and only production data – there are no export and import data. On the assumption that import from outside EU27 (mainly from China) equals EU27 export, those figures reflect the EU27 consumption;
- Communication with CELMA[7] gives the impression that there are sales in the other PRODCOM categories but that these sales are statistically regrouped into the three categories with data in Eurostat;
- Similar luminaires are used in non-domestic lighting, e.g. Horeca;
- Luminaires for fluorescent lamps and for street lighting are not included (see EuP studies on street and office lighting).

Concluding assumption on domestic and non-domestic luminaire sales:

[7] Federation of National Manufacturers Associations for Luminaires and Electro technical Components for Luminaires in the European Union. CELMA represents 16 national associations.

- Discussions with a central member of CELMA concluded that an average sales of 2 luminaires per household per year is a realistic value.
- The above Prodcom production data also includes production from the non-domestic sector. However, the luminaire sales in the non-domestic sectors are assumed to be 1.5-2 times the sales amount for the domestic sector and the non-domestic sales are assumed to be the difference between import of luminaires from China and the EU27 export of luminaires (as mentioned above is Eurostat at present only including production data and neither import nor export data).

2.2 Market and stock data

The purpose of this section is to provide market data for the identification of the most representative products in the European market and for the EU-wide environmental impact assessment of the product group 'domestic lighting' (chapters 5 and 8) as defined in section 1.1. Another purpose is to provide market inputs for scenario analysis up to 2020 (chapter 8).

Market and stock data are required for the following time periods:

- 1990 (Kyoto reference) or 1995;
- 2003-2007 (most recent real data);
- 2010-2012 (forecast, end of Kyoto phase 1) in a BAU (Business as Usual) scenario;
- 2020-2025 (forecast, year in which all – or at least a substantial share of - new ecodesigns of today will be absorbed by the market) in a BAU scenario.

Please note that it is not the purpose of chapter 2 to forecast the effect of future policy options related to domestic lighting (this is handled in chapter 8). Future policy options and their estimated impacts are discussed in chapter 8.

In order to assess the environmental impact, according to the MEEuP methodology, 'primary MEEuP market parameters' that will be used for impact modelling in chapters 5, 7 and 8 are identified (see Table 2.4). These parameters should reflect:

- Installed lamps (stock) in domestic lighting according to the product categories defined in section 1.1 most recently (2003-2007) and in the past (1990 or 1995 estimation) per EU-27 country;
- Lamp and luminaire sales growth (% or physical units) according to the product categories defined in section 1.1 to forecast the impact in Business as Usual for 2011 and 2020 for a BAU scenario;
- Average Product Life (in years) for lamps and for luminaires;

From the above data, the following dedicated MEEuP parameters will be derived:

- Total sales of lamps according to the product categories defined in section 1.1 versus generic data, (also in €, when available);
- Total lamp sales estimated when purchasing a new luminaire versus replacement lamp sales for existing luminaires (derived, if available);

- Total sales of luminaires according to the product categories defined in section 1.1 versus generic data, (also in €, when available);

In this section 'additional MEEuP model parameters' are defined when the 'Primary MEEuP market parameters' are not available.

The lamp life in years can be deduced, based on the average operational hours and the operational lifetime in hours. Operational lifetime data are included in chapter 4.

For non-ballasted lamp technologies, luminaires have no limitation on life time due to operational hours, while there is a limit due to the ballast for technologies as CFL and LED.DLS are primary non-ballasted and for this luminaire life in years seems to depend primarily on rebuilding the home and on changes in fashion. The luminaire life time is calculated based on total sales of luminaires in relation to the domestic stock of luminaires.

Table 2.4 gives an overview of the market parameters that are chosen to be included in the MEEuP model for EU-27. Regarding the parameters, it is important to note that:

- 1, 2, 3, 6, and 8: available data per EU-27 Member State are used, which are then aggregated to generate total EU-27 data.
- 1, 2, 5, 6, 7, and 8: data change over the concerned time frame 1990-2020 (forecast trends), but these data do not vary between different scenarios.
- 3 and 4 data change over the concerned time frame 1990-2020 (forecast trends), and these data also vary depending on the scenario that is applied: business as usual, least life cycle cost, best available technology etc.

Table 2.4: Input data included in the MEEuP Model totals for EU-27

Ref.	**Table. inputs for EU-27 Totals**	**Unit**	**Primary MEEuP market parameter**	**Additional MEEuP market Parameter**
1	Number of households per country and total	Households		X
2	Increase in number of households (per 5 years)	%		X
3	Number of different types of lamps and luminaires per household	Lamps Luminaires		X
4	Per lamp types % division on NDLS and DLS lamps	%	x	
5	Forecast of increase in number of lamps (per 5 years)	%	x	
6	Weighted average Wattage per lamp type	W	x	
7	Lamp life time per lamp type	Hours		X
8	Average operational hours per lamp type	Hours/year	x	
9	Luminaire life time for different categories	Years		x

Ballasts for LFL and CFL in the domestic sector are included in the luminaire that customers buy. As a consequence, they are not handled as a separate parameter in this study on domestic lighting. For details on ballasts, please refer to the preparatory study on Office lighting (Lot 8)[7].

[7] Preparatory Studies for Eco-design Requirements of EuPs, Lot 8: Office lighting, Final Report (April 2007).

For details on power supplies for low voltage halogen lamps, please see the study on external power supplies (Lot 7)[8]; the sales volume is included in luminaire sales for HL-LV. LED power supplies are low in sales and were neglected in chapters 2-6, but they will be used as BAT from chapter 6 on.

Luminaires for the domestic sector include a huge amount of different products with a very large price range. They are sold by thousands of luminaire manufacturers organised in CELMA. Mainly decorative elements can increase the price of domestic luminaires. This study does not aim to assess those decorative elements (see scope and the related system approach in chapter 1). Therefore neither average nor maximum domestic luminaires prices are evaluated. Luminaire related prices will be limited to the minimum price increase when applicable (see chapter 4 and 6).

Section 2.2.5 summarizes the market and stock data that will be used in the other chapters of the study.

2.2.1 Data retrieval

The following 4 approaches for retrieving market data (complementary to Eurostat data in section 2.1) were explored:

Literature research and EU R&D project data: various studies have been conducted on the energy use of domestic lighting for EU R&D programmes and several Member States have delivered useful data on the number of installed lamps and their related energy consumption. The most recent overview of the global trade in lamps and lighting products, and the global market value and trends can be found in the recently published IEA Light's Labour's Lost (IEA, 2006).

Consultation of ELC[9], major retailers, and CELMA: a request for lamp and luminaire sales data and any other relevant information for part 2 was launched at the meetings with ELC and CELMA (Oct. 2008 and Jan. 2009). In March 2009, ELC provided aggregated sales data for 2007 and 2008 for reflector lamps. CELMA was unable to give data but a CELMA member agreed with the conclusion in 2.1.3 related to generic luminaire sales volumes.

Expert-inquiry: in spring 2007, DG JRC (Joint Research Centre) of the European Commission sent a 10-question-survey about installed lamps to experts in different Member States and to other lighting related organisations. Experts from nearly all EU-27 filled in the questionnaire and the responses provided useful data on number of lamps per household and numbers and use of energy efficient lamps for the different Member States. These data are used along with new and more detailed lamp information collected in the EU R&D project REMODECE[10]. This project includes the results from the 12 cooperating countries plus some national research projects in other EU countries. Data for the remaining countries are estimated based on the above data.

Unfortunately, REMODECE did not specify if the lamps were reflector lamps. To compensate for this, a reflector lamp expert survey was performed among participants in the EU R&D projects

[8] Preparatory Studies for Eco-design Requirements of EuPs, Lot 7: External power supplies and battery chargers (January 2007).
[9] European Lamp Companies federation including 8 members
[10] Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe

REMODECE and ENERLIN. Many replies were received, but the experts underlined that their answers were rather uncertain.

Calculated estimations based on the number of households in EU-27 and stock data for some member countries measured from EU R&D projects: Data on the number of households per Member State can be found in Eurostat. The EU-27 total installed base of domestic lamps can be derived by combining this with the lamps-per-household data available for a number of EU countries along with the average measured and/or estimated lifetime of different lamp types. Forecast on population, number of households, number of luminaires and lamps can be used to make projections regarding the future installed base and annual sales of domestic lighting products (up to 2020).

Enquiry for all stakeholders: a lamp questionnaire for sales data and other relevant market information was addressed directly to ELC, 2 major European lamp retailers, and The China Chamber of Commerce. All other stakeholders were also invited to contribute; the questionnaire can be downloaded by registered stakeholders on the project website (www.eup4light.net). Only ELC replied.

2.2.2 Annual lamp and luminaires sales

The objective of this section is to determine the current sales as reliably as possible for the domestic lighting lamp types as defined in section 1.1 for the latest full year for which data are available.

Analysis of lamp data received from ELC

In December 2007, ELC answered the questionnaire, as far as possible, for the period 2004-2006. ELC data were split up in 4 regions of the EU: Central & Eastern, Middle, Northern and Southern. The available data include sales in all sectors in the society and unfortunately no data are available on the division of these sales between different sectors. In March 2009, ELC provided aggregated reflector lamp data for 2007 and 2008.

The sales figures for application in domestic lighting can only be estimated using information from research, lamp industry experts and assumptions. At present, the most used lamps in the domestic sector are GLS and halogen lamps, a small amount of linear fluorescent lamps (LFL's) and an increasing amount of CFL's with integrated ballast.

Table 2.5 shows the annual ELC sales and shows for 2006 (last year with both NDLS + DLS sales):

- DLS (reflector lamps) represents 12% of the total sales volume.
- GLS-R contributes with 11% of the GLS sales.
- HL-LV-R contributes with 55% of the total HL-LV sales.
- HL-MV-R contributes with 42% of the total HL-MV sales (growing faster than HL-LV).

Table 2.5: Volume of ELC (only including ELC members) reflector lamp sales in EU-27, 2004-2008

Lamp type	2004	2005	2006	2007	2008	Change 2004 - 2008	DLS part of NDLS+DLS
GLS-R	*163,822,491*	*144,513,034*	*138,360,572*	*162,390,388*	*150,870,523*	*-8%*	*11% (2006)*
HL-LV-R	*66,915,971*	*71,422,261*	*73,181,823*	*68,185,164*	*81,048,849*	*+21%*	*55% (2006)*
HL-MV-R	*28,753,170*	*29,758,531*	*31,705,477*	*46,302,947*	*62,965,941*	*+118%*	*42% (2006)*
CFLi-R				*1,086,647*	*2,687,760*	*+147%*	*1% (2007 estimate)*
Total	*251,491,632*	*245,693,826*	*243,247,872*	*277,965,146*	*297,573,073*	*+7%*	*12% (2006)*

Concerning GLS and HL sales, the annual percentage distribution of the sales on wattages and regions is not changing much in the period 2004-2006, so to get a picture of the distribution on wattages it is enough to look at the last year with available data (2006).

For GLS reflector lamps, Table 2.6 shows that:

- GLS-R lamps sales are distributed as 55% 40W, 27% 60W, 9% ≤ 25W and finally the last 9% includes the wattages 75W, 100W and 150-200W (around 12,300,000/year),
- In general, the sale of GLS reflector lamps is decreasing especially for the high wattages 75W, 100W and 150-200W,
- The weighted average wattage is 51W in 2006.

Table 2.6: GLS-R % distribution of ELC sales in EU-27, 2006

% ELC sales 2006	***EU Region***				
GLS-R Wattage	*Central & Eastern*	*Middle*	*Northern*	*Southern*	***Total***
≤25W	2.0	5.0	1.4	0.6	**9.0**
40W	10.1	37.7	2.4	4.9	**55.2**
60W	5.0	18.1	0.4	3.4	**26.9**
75W	0.2	1.6	0.0	0.6	**2.4**
100W	0.2	2.4	0.0	0.8	**3.5**
150-200W	0.3	2.3	0.0	0.4	**3.0**
Total	**17.7**	**67.1**	**4.3**	**10.8**	**100**
Wattage	**2004**	**2005**	**2006**	**Decrease in sales (%)**	
<=25W	13,930,960	12,785,155	12,424,272	**-11%**	
40W	88,641,372	79,042,894	76,388,608	**-14%**	
60W	43,959,116	38,481,869	37,224,249	**-15%**	
75W	4,682,156	3,912,891	3,307,753	**-29%**	
100W	6,412,696	5,557,390	4,840,024	**-25%**	
150-200W	6,196,190	4,732,834	4,175,666	**-33%**	
Total	**163,822,491**	**144,513,034**	**138,360,572**	**-16%**	

For halogen low voltage lamps, Table 2.7 shows that:

- HL-LV-R is one third ≤ 20W and two third >20W,
- The largest sales increase is seen for HL-LV-R ≤ 20W,
- Assuming average wattage >20W is 35W and that there are one third 10W hidden in the ≤ 20W category, the weighted average is 29W.

Table 2.7: HL-LV EU-27 % distribution of ELC sales in 2006 and 2004-6 sales increase

% ELC sales 2006	***EU Region***				
Wattage	*Central & Eastern*	*Middle*	*Northern*	*Southern*	***Total***
HL-LV-R <=20W	2.2	20.1	2.0	9.8	**34.2**
HL-LV-R >20W	3.8	37.3	2.7	21.9	**65.8**
H-LV-R total	**6.0**	**57.4**	**4.8**	**31.7**	**100**
Wattage	**2004**	**2005**	**2006**	**Increase in sales (%)**	
HL-LV-R <=20W	19,466,508	24,142,385	25,010,136	**28%**	
HL-LV-R >20W	47,449,463	47,279,876	48,171,687	**2%**	
Total	**66,915,971**	**71,422,261**	**73,181,823**	**9%**	

HL-LV-R 15W is included by ELC in the general category because of lack of answers

For halogen mains voltage lamps, Table 2.8 shows that:

- Sales of HL-MV-R are distributed as follows: 42% >60W, 35% 60W and 23% ≤ 40W.
- Sales of HL-MV-R ≤ 40W are increasing very fast with a 44% sales growth between 2004 and 2006,
- Assuming the average wattage >60W is 75W and the average wattage <=40W is 35W, the weighted average is 60W but since the sales increase very fast for wattage <=40W, it is for the near future considered more appropriate to select 50W as an average.

Table 2.8: HL-MV EU-27 % distribution of ELC sales in 2006 and 2004-2006 sales increase

% ELC sales 2006	***EU Region***				
Wattage	*Central & Eastern*	*Middle*	*Northern*	*Southern*	***Total***
HL-MV-R <=40W	2.3	15.8	2.0	3.2	**23.2**
HL-MV-R 60W	1.8	23.3	3.4	6.7	**35.2**
HL-MV-R >60W	1.5	30.0	3.1	7.0	**41.6**
HL-MV-R total	**5.6**	**69.0**	**8.6**	**16.8**	**100**
Wattage	**2004**	**2005**	**2006**	**Increase in sales (%)**	
HL-MV-R <=40W	5,103,999	5,863,506	7,369,583	**44%**	
HL-MV-R 60W	10,176,305	10,513,726	11,151,501	**10%**	
HL-MV-R >60W	13,472,866	13,381,299	13,184,393	**-2%**	
Total	**28,753,170**	**29,758,531**	**31,705,477**	**10%**	

Analysis of total EU-27 lamp sales (including companies outside ELC)

Table 2.9 summarizes sales data for the year 2006:

- The total for GLS is adjusted to 1350 million (from 1067 million in Eurostat, see Figure 2.1) as Eurostat data are lower than the sum of the sales data from the manufacturers – maybe because some sales of packages of two bulbs sometimes go into statistics as sales of

one bulb. Reasons for significant differences between sales data and apparent consumption from official statistics are extensively discussed in the MEEuP report (VHK, 2005).

- ELC data are summarized data from Table 2.5.
- 2 major European lamp retailers have informed of the rough size of their 2006/2007 sales of own-brand lamps.
- Other sales are sales from other manufactures assumed to be the residual sales to meet the total Eurostat sales.
- ELC provided their 2006 CFLni sales, i.e. 170 million.

Table 2.9: Volume of EU-27 sales (millions/year) for all sectors in 2006

Lamp type	Total (Euro-stat)	ELC Sales	2 major European lamp retailers Sales	Other Sales (residual)	Non Direct and Direct Lamps %
GLS	1350	1096	62	44	NDLS 89%
GLS-R		138	10		DLS 11%
HL-LV	300	60	26	120	NDLS 45%
HL-LV-R		73	21		DLS 55%
HL-MV-LW	330	20[11]	10	193	NDLS 58%
HL-MV-HW		24	1		
HL-MV-R-LW		19	46		DLS 42%
HL-MV-R-HW		13	4		
CFLi	426	97	60 (3% DLS)	159	NDLS 99%
CFLni		90 ¤	0	20	-
CFLi-R		1 (2007)	5 (estimate for 2007)		DLS 1%

¤ Value estimated from EuP lot 8 information and informal data about ELC CFLni sales in 2007

Table 2.9 shows that ELC is covering nearly all GLS and LFL sales but less than half of the HL and CFL sales. The NDLS/DLS distribution for halogen lamps is derived from new data received in 2008 and the distribution is a bit different from the earlier developed MEEuP model (see section 2.2.6) based on 2006 data. A sensitivity analysis was executed in relation to chapter 8 in part 1 of the study. It did show that the influence of using the new NDLS/DLS distributions would only result in a small difference of about 2-3% in energy savings with no influence on the outcome of comparison and ranking of the scenarios.

Analysis of total EU-27 luminaires sales

CELMA regrets that they are unable to provide any luminaire data or estimates of sales within different types of luminaires.

The only available luminaire sales data come from Eurostat. Table 2.2 shows yearly sales of 2 luminaires per household divided up into three categories:

- 5% Table, desk, bedside and floor-standing lamps
- 76% Chandeliers and other ceiling and wall fittings
- 19% Lamps and fittings (filament and tubular fittings)

[11] ELC HL-MV sales 44 million and HL-R-MV sales 32 million is divided on LW (≥75W) and HW (>75W) by own judgement

Unfortunately, the division is not very specific because only three of the sixteen Eurostat categories seem to be in use as a kind of "sum-up" categories.

2.2.3 Stock of different installed lamps and luminaire types per household

Stock of installed lamps

Stock data in part 1 of the study were provided in response to an end-user survey in the EU R&D project REMODECE including 500 consumers per country for 11 countries. Besides this, Sweden and UK have provided data from large national surveys performed in 2007. They include data from a JRC questionnaire to national experts [Bertoldi and Atanasiu, 2007] and it was estimated that the mentioned 13 countries use 76% of the total EU-27 stock. The detailed data for the 13 countries were finally rescaled to four EU regions and summed for EU-27. The results (included in the MEEuPs model as shown in section 2.2.6) were:

- The EU-27 average is 24.3 installed lamps/household in 2006 (variation: 10-40 installed lamps/country),
- The average share of GLS lamps is 13.15 GLS/households equal to 54% of the lamps,
- The average share of HL-LV is 4.46 equal to 18% of the lamps,
- The average share of HL-MV is 1.32 equal to 5% of the lamps,
- The average share of LFL is 1.83 equal to 8% of the lamps,
- The average share of CFLi is 3.58 equal to 15% of the lamps.

Unfortunately, nearly all the above data is not split up in non-reflector and reflector lamps. As shown in Table 2.8, sales of halogen reflector lamps have increased rapidly the last years. By the end of 2008, the participants in the EU R&D projects REMODECE and Enerlin were asked about their estimate of the current stock of reflector lamps. The answer is shown in table 2.10.

Table 2.10: Survey including estimates of the stock of reflector lamps by the end of 2008

REFLECTOR LAMPS		Estimates - no measured or surveyed data									
				GLS-R	HL-LV-R		HL-MV-R		CFLi-R		
EU region	Country	Number of house holds in millions		E27, E14	GU4 GU5.3	G53	E14, E27, B14d, B22d	GU10, GZ10	E14, E27, B14d, B22d	GU10, GZ10	Lamps in total
		Total	included	no/HH	no/HH		no/HH		no/HH	no/HH	no/HH
Central and Eastern EU	BG	3.7	1	1	1	0	0	0	0	0	2.0
	CZ	4.4	1	1	2	0	0	0.1	0.01	0	3.1
	CY	0.3									
	EE	0.6									
	HU	4.1									
	LV	1.0	1	3.5	2	0	1	2	0.5	0	9.0
	LT	1.3									
	MT	0.1									
	PL	13.3	1	2	3	0	0.1	0.5	0	0	5.6
	RO	8.1	1	1.5	0.5	0.1	0.3	0.6	0.0	0.0	3.0
	SK	2.1									
	SI	0.7									
Middle EU	AT	3.3									
	BE	4.3	1	1	4	0	0.5	0.4	0	0	5.9
	FR	32.2	1	0	3.6	0,0	0	0.7	0	0	4.3
	DE	39.1	1	1	5	0	0	1	1	0	8.0
	EI	1.4									
	LU	0.2									
	NL	7.0									
	UK	26.2									
Northern EU	DK	2.5	1	0.5	7	0	0.2	2	0.1	0	9.8
	FIN	2.5									
	SE	4.5									
Southern EU	GR	3.7	1	0.7	1.2	0	0.2	0	0.1	0	2.2
	IT	22.5	1	1.5	6.9	0	2.1	0	0	0	10.5
	PT	4.2	1	2	4	0	0.5	0.5	0	0	7.0
	ES	17.2									

EU region	Number of		GLS-R	HL-LV-R		HL-MV-R		CFLi-R	
	Cap		E27, E14	GU4 GU5.3	G53	E14, E27, B14d,	GU10, GZ10	E14, E27, B14d,	GU10, GZ10
	Total	included	no/HH	no/HH	no/HH	no/HH	no/HH	no/HH	no/HH
Central+Eastern EU	39.7	0	1.6	1.9	0	0.2	0.5	0	0
Middle EU	113.7	0	0.6	4.3	0	0	0.8	0.5	0
Northern EU	9.5	0	0.5	7.0	0	0.2	2.0	0.1	0
Southern EU	47.6	0	1.5	5.8	0	1.6	0.1	0	0
EU 27	210.6	0	1.0	4.3	0	0.4	0.6	0.3	0

Compared to the BAU forecast in section 2.2.7 (see Figure 2.2) GLS-R and HL-MV-R are in line with our BAU forecast while we consider the estimates of HL-LV-R and CFLi-R to be higher than the actual EU-27 stock mainly due to many countries are missing in the above survey.

In part 1, the EU-27 stock of lamps for 1995 was estimated although the EU did not include that many countries at that time. This calculation showed an average of 21.3 lighting points/household (variation: 6-36 points/country) including 18.0 GLS (85%), 0.9 HL-LV, 0 HL-MV, 1.4 LFL and 1.0 CFLi. We estimate that the 21.3 lighting points/household in 1995 included 1.5 GLS-R and 0.5 HL-LV-R (we don't have 1995 reflector lamp data so it is our best guess).

Stock of installed luminaires

As explained in chapter 1, in this study the luminaires are treated as belonging to the system environment of the lamp or light source. There is an enormous market of different luminaire types for domestic lighting.

Unfortunately, no direct EU27 luminaire stock data are available. However with 24.3 installed lamps / household in EU27, we assume that every household uses 20.7 luminaires (85% of 24.3

lamps/home) including a few luminaires per home that contain more than one lamp (the assumption is based on impressions from the audit in the REMODECE project – unfortunately the number of luminaires was not counted in REMODECE) The total number of luminaires is thus assumed to be 85% of the total number of lamps which is equal to around 4300 million luminaires used in the domestic sector for the year 2006 (see the MEEuP's model in section 2.2.5) of which 770 million luminaires are for DLS.

CELMA[12] proposed to define luminaires according to their market share in categories shown in Table 2.11 also containing characterisation by different technical parameters.

Table 2.11: Luminaire categories according to commercial terminology (catalogues, websites)

Luminaire category	Mounting method	Electrical connection	Light distribution	Ingress protection
Downlights (recessed mounted)	ceiling integrated	fixed (wired)	Directional light distribution	≥IP2X
Suspension (chandeliers)	ceiling suspended	fixed (wired)	Any	≥IP2X
wall&ceiling	surface mounted	fixed (wired)	Any (excluding Narrow beam spotlights)	≥IP2X
Desk	free surface standing	plug	Directional light distribution	≥IP2X
Table	free surface standing	plug	Non directional light distribution	≥IP2X
Floor	free surface standing	plug	Any	≥IP2X
Spotlights	surface mounted	fixed (wired)	Narrow beam directional light distribution	≥IP2X
Outdoor	surface mounted/floor standing	fixed (wired)	Directional light distribution(often) or non(rare)	≥IP44

Table 2.12 shows guessed estimates of the market share of the different luminaire categories provided by CELMA which are average values of data collected from some large members of CELMA in June 2009.

Table 2.12: CELMA guess estimates of luminaire category market distribution, percentages with cap lock in effect and control properties

Luminaires categories	Market share in %	Percentage with GU9, GU10 or R7S cap	Percentage of dimmers	Presence Detectors	Daylight control	Range of wattage
Downlights (recessed mounted)	11%	70%	0%	no	no	2-100
Spotlights	18%	45%	10%	no	no	2-100
Suspension	19%	25%	5%	no	no	20-300
Wall & ceiling	22%	20%	5%	no	no	20-300
Desk	5%	15%	5%	no	no	5-60
Table	4%	5%	15%	no	no	20-100
Floor	5%	35%	25%	no	no	20-300
Outdoor	16%	35%	1%	**yes**	**yes**	20-300

CEPAPI members in Belgium has delivered 2008 sales data for **wall swiches** used to operate domestic luminaires:

- 91% traditional mechanical control switches
- 4% electronic control switches (timers, PIR detectors) with electromagnetic relay
- 5% electronic control switches with electronic control (FET, IGBT, Triac,..) e.g. solid state relay or phase controlled dimmers.

[12] www.celma.org

The above data could serve to estimate the energy saving on luminaires having equal Light Output Function (LOF) as defined in chapter 1.

Nowadays, spot lights and down lights mainly use DLS lamps. As explained later in chapter 3, there is no optical improvement potential for spotlights using DLS lamps because those lamps are generally not shielded and there is thus no loss of functional lumen.

The other categories of luminaires mainly use the NDLS lamps. The above luminaire data are thus also relevant for the impact scenarios calculated in part 1 with the installed base of NDLS lamps. The analysis can be handled by a correction factor applicable to the part 1 scenarios and their improvement options (if any). For those luminaires only the ratio or percentage on saved power consumption will be assessed and not the absolute LOF.

For the calculation of potential energy savings, it is also important to know the amount of up-lighter luminaires, equipped with high wattage, linear halogen lamps. A large UK lighting study performed in 2007, found that there could be installed up to 6 million halogen up-lighters in total for all sectors in the UK. Assuming that half of these luminaires are used in the domestic sector, it means that 1 out of 8 households has an up-lighter luminaire which for EU27 is equal to 26 million households. This is assumed to be representative for Western European countries while it might be too high for Eastern European countries. Based on the UK usage, the usage for all sectors in EU27 is roughly estimated to be 40 million up-lighters.

Table 2.12 includes an estimate of 5% floor lamps where 35% are estimated to include R/S cap. The total is thus equal to 210 million households * 20.7 luminaires/hh * 5% * 35% = 76 million uplighters alone for the household sector. Compared to the UK numbers above, the estimated share for R7S cap in Table 2.12 is considered to be too high. A total use of 40 million up-lighters for all sectors in EU27 is still our best estimate.

Concerning lighting control information contained in Table 2.12, the relative savings (if any) related to dimmers, presence detectors and daylight controls will be assessed in chapter 6.

Please note some of the luminaires for lamps within the scope of this study are also used in Horeca sector and shop lighting.

Average lamp wattages for different lamp types

In part 1, selection of average lamp wattages was based on the studies: EURECO (1999-2000), “Eclairage 100" (1999), UK lighting market transformation survey (2007) and the Podo project (2005-2006). Unfortunately, nearly none of these studies include details about reflector lamps. Therefore, estimates of the average wattages are based on the weighted average of wattage sales data and trends in section 2.2.2 although the wattage sales distribution might not be the same as the wattage stock distribution.

Based on the above information, the following average lamp wattages were chosen for reflector lamps:

- 50W for GLS
- 50W for HL-MV. In Part 2 there is no division on HL-MV-LW and HL-MV-HW as there is not a large variation in wattage size for DLS as there was for NDLS in part 1.
- 35W for HL-LV.

- 12 W for CFLi-R. At present, no wattage information is available from ELC. 12W is chosen as base-case because the lumen output is comparable to the wattages for the other lamp types.

2.2.4 Average operational hours per lamp type

The average operational hours per lamp type is an important parameter necessary for estimating the total stock of lamps along with the technical lamp lifetime and lamp sales.

The average operational hours for lamps depend on the user behaviour and on the environment; these topics are discussed in chapter 3 and also include presence of household members, activities, lighting control e.g. by clock, burglar protection, outdoor lighting level and/or presence detection. For part 1 of this study, measured data were used from different EU R&D activities/projects. Unfortunately, none of these studies includes detailed information on distribution in DLS and NDLS.

- GLS-R 400 hours/year
- HL-MV-R 450 hours/year
- HL-LV-R 500 hours/year
- CFLi-R 800 hours/year.

Some stakeholders claim that DLS lamps may have larger operating hours compared to NDLS because are not used in cellars and similar places. On the other hand, some of the DLS lamps are placed as down lighers in staircases, corridor and hall with a low level of use . As the measured data is not divided on NDLS and DLS, it is decided to use the same operational hours for DLS as for NDLS.

The impact analysis also includes the use of the lamps in the non-domestic sector, so the weighted average operational hours for all sectors used in the calculation are actually higher than the above values as shown in section 2.2.6.

Finally, it has to be stressed that the impact assessment calculations use **lumen / hour** as the functional unit. As a consequence, differences in operational hours will have a low impact (only for the economic assessment) on the calculations in chapter 7 (improvement options) and 8 (scenarios). Chapter 8 will contain a sensitivity analysis in order to find the uncertainty of the results related to the size of the operational hours.

2.2.5 Summary of MEEuP market parameters

Table 2.13 summarizes the data to be used in the EcoReport calculations in the next chapters of the study. Comments on this table are:

- 2006 stock of installed lamps/household (from section 2.2.3); these data are to be considered as bottom line data because a luminaire with two lamps might have counted as one and some sockets might have been forgotten.
- The division on %NDLS and %DLS is based on sales data in section 2.2.2.
- Weighted wattages (see section 2.2.4)

- Average operational hours (see section 2.2.5)
- Lamp lifetimes (found in chapter 4 by studying the manufacturer's catalogues).
- Forecast of the stock of installed lamps for 2011 and 2020 (estimates). Alternatively, it was considered to perform a trend analysis based on the UNECE database[13] but this was refused due to large changes between lighting sources within the last few years.
- Any yearly forecast of the stock = Yearly replacement sales + Yearly change in stock.
- Yearly lamp replacement sales = Stock of lamps in 2006 * operational hours per year/lamp lifetime.
- Yearly change in sales of lamps is calculated from a forecast of the stock of different lamps as explained in part 2.2.7 and 2.3.
- Number of homes (not available in Eurostat) is collected from a comparative study of UNECE House statistics (old data from 2002), House Statistics in EU (2004) other studies and national statistics. The actual number of homes (dwellings) in EU-27 is found to be 210 million homes.
- The growth rates are related to trends and are explained in section 2.3.1.
- The yearly sales of luminaires divided on categories are based on Eurostat data as explained in section 2.2.2.
- Estimation of the stock of installed luminaires/household is primarily based on the found stock of lamps/household and the estimated average lamps/luminaire (see section 2.2.3).
- Life time for luminaires is calculated based on the forecasted stock of lamps in Table 2.13:
    - 'New sales' = (31.0-24.34) lamps*0.85 lamps/luminaires/(2020-2006) = 0.40
    - 'Replacement sales' = 2.0 – 0.40 = 1.6 luminaires
    - Luminaires lifetime (average) = 24.34 lamps * 0.85 lamps/luminaire/1.6 luminaires = 13 years

[13] The database model of the Statistical Division (UNECE/STAT) maintained by the Environment and Human Settlements Division contains data with specific reference to data on housing and building. Data are collected for the ECE Bulletin of Housing and Building Statistics and through the Country Profiles on the Housing Sector from a number of both national and international sources.

Table 2.13: MEEuP lighting model with Business as Usual (BAU) forecast

Scenario: BAU — **MEEuP Lighting Model for EU27**

Capita	
477,000,000	
Homes	
210,000,000	
Capita/home	
2.27	

Input data / Calculated

Domestic sector	GLS-F	GLS-C	HL-MV LV	HL-MV HV	HL-LV	LFL	CFLi	Total
Stock of lamps (NDLS•DLS) per home 2006	9.20	3.95	0.61	0.71	4.46	1.83	3.58	24.34
% NDLS	99	66	55	55	49	100	99	
% DLS	1	34	45	45	51	0	1	
Stock of lamps	1932000000	829500000	128100000	149100000	936600000	384300000	751800000	5111400000
Stock of NDLS lamps	1912680000	547470000	70455000	82005000	458934000	384300000	744282000	4200126000
Stock of DLS lamps	19320000	282030000	57645000	67095000	477666000	0	7518000	911274000
Lamp life time (hours)	1000	1000	1500	1500	3000	12000	6000	
Average operational hours (hours/year)	400	400	450	450	500	700	800	
Replacement Sales per year	772800000	331800000	38430000	44730000	156100000	22417500	100240000	1466517500
Forecast of stock (NDLS•DLS) in 2011	4.9	2.5	3.0	2.0	5.1	2.0	8.1	27.6
Stock of lamps	1022700000	525000000	630000000	420000000	1071000000	420000000	1701000000	5789700000
Stock of NDLS lamps	1012473000	346500000	346500000	231000000	524790000	420000000	1683990000	4565253000
Stock of DLS lamps	10227000	178500000	283500000	189000000	546210000	0	17010000	1224447000
Forecasted change in sales in 2007	-181860000	-60900000	100380000	54180000	26880000	7140000	252760000	198580000
Total sales 2007	590940000	270900000	138810000	98910000	182980000	29557500	353000000	1665097500
NDLS sales 2007	585030600	178794000	76345500	54400500	89660200	29557500	349470000	1363258300
DLS sales 2007	5909400	92106000	62464500	44509500	93319800	0	3530000	301839200
Forecast of stock (NDLS•DLS) 2020	3.5	2.3	4.7	2.5	5.9	2.0	10.1	31.0
Wattage weighted average (W)	54	54	40	300	30	38	13	
Lamp Wattage Factor	1	1	1	1	1.11	1.05	1.05	
Electricity consumption in 2006, TWh (total)	41.73	17.92	2.31	20.13	15.59	10.73	8.21	
Electricity consumption in 2006, TWh (NDLS)	41.31	11.83	1.27	11.07	7.64	10.73	8.13	
Electricity consumption, %	35.8	15.4	2.0	17.3	13.4	9.2	7.0	

Data control for 2007	GLS-F	GLS-C	HL-MV LV	HL-MV HV	HL-LV	LFL	CFLi•CFLni
Eurostat Apparant consumption, EU27, 2007	811626000	347000000	318000000		310460000	388072000	630000000
Domestic 2007 Sales/Apparant consumption 2007	0.7	0.8	0.4	0.3	0.6	0.1	0.6
Eurostat includes both domestic and commercial customers.							
Apparent EU27 consumption = Production in EU27 + Imports – Exports							

Non-domestic sector	GLS-F	GLS-C	HL-MV LV	HL-MV HV	HL-LV	LFL	CFLi•CFLni
2007 sales in the non-domestic sector	220686000	76100000	80280000		127480000	358514500	277000000
Sales for the non-domestic sector is calculated as the residual.							

Table 2.13 does't include LEDi-R since the size of LED sales in the domestic sector are actually minor and no data are available in the sales statistics. Besides that, the performance and quality of LED lamps/luminaires are actually often low. The very high prices of LED lamps sets a barrier for intrusion. Anyway, LEDi-R will most likely come into use in the period until 2020 but the speed of intrusion is very unsure. Therefore, it is decided to handle the use of LEDi-R as an improvement option in Task 7.

Figure 2.2 shows the BAU (Business As Usual) forecast of the yearly DLS stock, for the domestic sector, of GLS-R, HL-MV-R, HL-LV-R and CFLi-R. The number of GLS-R is decreasing while the use of halogen lamps is increasing, especially the HL-MV-R. The use of CFLi-R is in an up-start phase and assumed to grow slowly because of a high price barrier and lock in effects (see chapter 3). The growth rates are related to trends explained in section 2.3.1. The forecast is also in line with the trends in sales for the last years shown in the section 2.2.2.

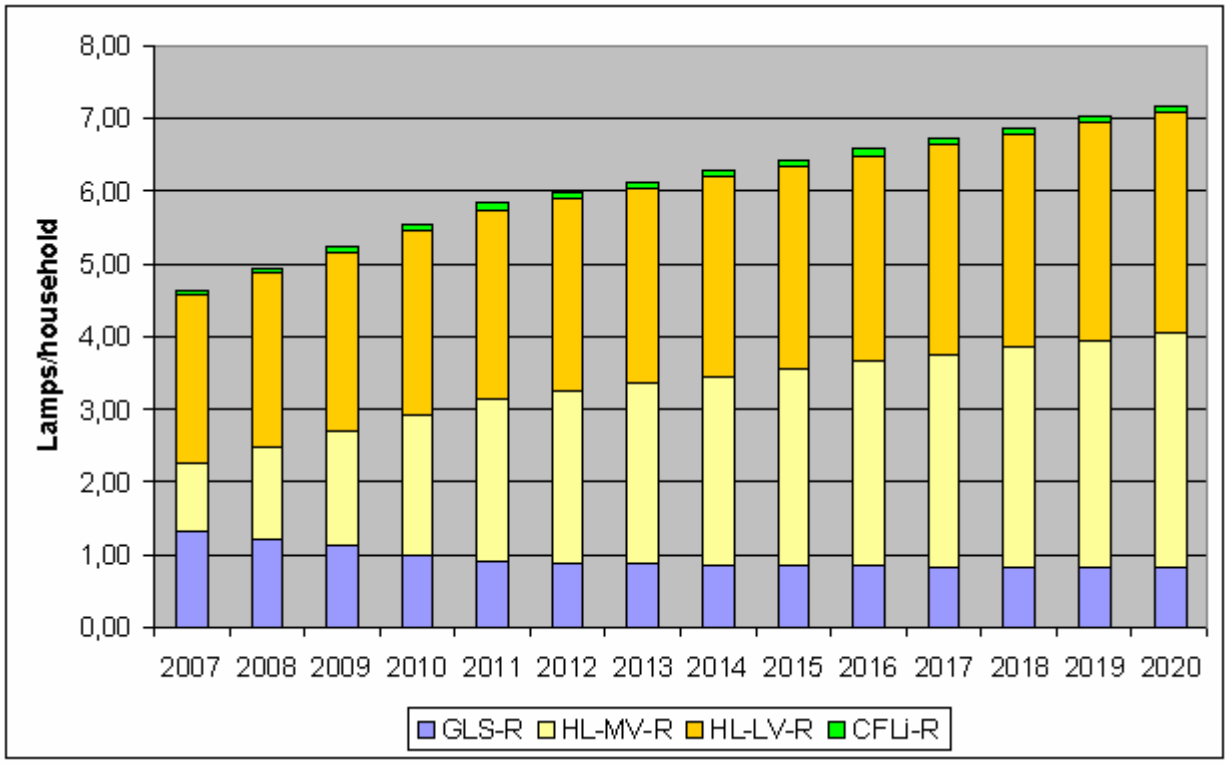

Figure 2.2: BAU (Business as Usual) forecast of the domestic DLS stock

Table 2.14 summarizes the domestic MEEuP data that are used to develop MEEuP data for all sectors.

Table 2.14: Lamp data and domestic stock for 2006 used in section 2.2.6

Lamp type	Stock of Domestic DLS lamps	Lamp life	Average operation per year	Base case wattages
	millions	Hours	Hours	Watt
GLS-R	320	1000	400	50
HL-MV-R	125	1500	450	50
HL-LV-R	478	3000	500	35
CFLi-R	6 (2007)	6000	800	12

2.2.6 Stock and sales MEEuP data for all sectors

The DLS base-cases (see section 2.2.4 and chapter 5) are used in order to investigate environmental and economic results for the domestic sector as well as "Other sectors" (non-domestic) with the assumption that lamp life, the average wattage, the lamp price and the shares of DLS lamps are the same as in the domestic sector.

The same CFLi-R's are assumed to be used both in the domestic and non-domestic sector as there don't appear to be any CFLni-R at the market.

In the calculations, it is assumed that the share of replacement sales (see definition in section 2.2.5) for the domestic sector can also be used for the non-domestic sector as we don't have detailed

information about this. The domestic replacement shares are: 131% for GLS-R-F, 122% for GLS-R-C, 35% for HL-MV-R, 85% for HL-LV-R and 28% for CFLi-R.

It is assumed that all base-cases in the non-domestic sector operate 1800 hours per year (250 working days/year with around 7 operating hours per day) for both NDLS and DLS lamps. The annual burning hours for all sectors are calculated in Table 2.15 based on a weighted average in 2006:

$$Operation\ hours_{All} = (Operation\ hours_{Dom} \times Stock_{Dom} + Operation\ hours_{Other} \times Stock_{Other}) / Stock_{All}$$

Table 2.15: Calculation of average operation hours per year for all sectors

	GLS-R-F	GLS-R-C	HL-MV-R	HL-LV-R	CFLi-R
Domestic sector	400	400	450	500	800
Non-Domestic	1800	1800	1800	1800	1800
All sectors	507	482	555	695	1056

The stock of lamps for "Other sectors" (non-domestic sectors) are calculated as:

Total Stock = (Lamp life /Operation hours) x Share of Replacement Sales x Total Sales

The stock in 2007 is calculated based on survey data from 2006 as well as 2007 Eurostat data.

Based on the above assumptions, formula and the market trends described in section 2.3, the BAU (Business as Usual) forecast shown in Table 2.16 is produced. This BAU forecast will be used in scenario calculations in chapter 8.

Table 2.16: BAU (Business as Usual) forecast of the DLS stock including all sectors

STOCK	GLS-R	HL-MV-R	HL-LV-R	CFLi-R	TOTAL
2006	320,492,926	135,276,750	562,212,950	10,103,333	**1,028,085,959**
2007	291,591,919	228,310,650	584,873,780	12,350,493	**1,117,126,843**
2008	268,863,050	299,335,970	599,377,647	14,977,744	**1,182,554,412**
2009	246,134,181	370,361,291	613,881,514	17,604,995	**1,247,981,981**
2010	223,405,311	441,386,611	628,385,381	20,232,246	**1,313,409,550**
2011	200,676,442	512,411,932	642,889,248	22,859,497	**1,378,837,119**
2012	198,644,874	537,463,182	654,094,289	23,486,644	**1,413,688,989**
2013	196,613,306	562,514,432	665,299,330	24,113,791	**1,448,540,859**
2014	194,581,739	587,565,682	676,504,372	24,740,937	**1,483,392,730**
2015	192,550,171	612,616,932	687,709,413	25,368,084	**1,518,244,600**
2016	190,518,603	637,668,182	698,914,455	25,995,231	**1,553,096,470**
2017	188,487,035	662,719,432	710,119,496	26,622,377	**1,587,948,340**
2018	186,455,467	687,770,682	721,324,537	27,249,524	**1,622,800,211**
2019	184,423,900	712,821,932	732,529,579	27,876,671	**1,657,652,081**
2020	182,392,331	737,873,182	743,734,620	28,503,818	**1,692,503,951**

Figure 2.3 shows the forecasted stocks of GLS-R, HL-MV-R, HL-LV-R and CFLi-R. The growth rates are related to trends explained in section 2.3.1.

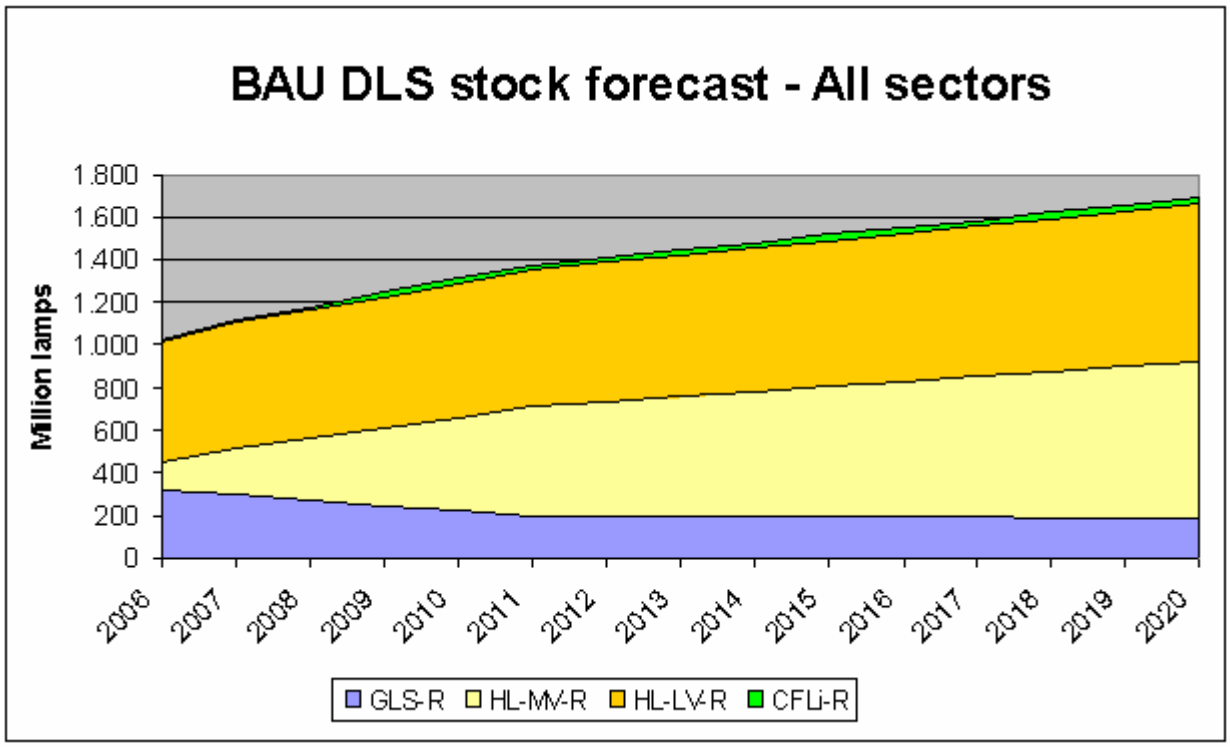

Figure 2.3: Business as Usual (BAU) forecast of the DLS stock including all sectors

Figure 2.3 shows that even without any legislation, the market share and the stock of GLS-R are relatively small and decreasing, falling from 31% in 2006 to 11% in 2020. The potential for energy efficiency primarily concerns the market share of halogen reflector lamps.

Following the assumption in section 2.2.3, the forecast of stock of luminaires is estimated to be 85% of the total number of lamps (NDLS+DLS). The amount of luminaire sales in the non-domestic sectors is assumed to be between 1.5 - 2 times the sales in the domestic sector (see section 2.1.3).

2.3 Market trends

2.3.1 General product design trends and features from marketing point of view

The number of lamps and luminaires are growing because of:

- Installation of more light sources (trend) along with the growing welfare;
- Central & Eastern EU expand their use of lighting most likely to a level similar to the rest of EU;

- Increasing living space per capita because of a growing number of people living alone;
- Shift to reflector halogen down-lighting typically includes a shift from one or two lamps to line(s) of lighting points.

One could fear that there is no natural limitation on this growth rate because the eye is able to adapt to a broad luminance range and daylight levels are by far not yet reached in domestic lighting.

Complaints about glare and/or overheating of the room due to the use of some of these new halogen reflector lamps might slow down this growth rate. These problems are already experienced in shop lighting, hotel receptions and new glossy kitchens with reflector lamps – they have sometimes . resulted in the installation of additional air conditioning. The overheating could also be reduced by using a cold mirror coating design for the reflector in order to transmit the IR radiation back towards the reflector[14].

The halogen market is expected to saturate in the future with a shift to energy efficient solutions by LED-R or CFLi-R, which are currently more expensive lamps and/or with lower performance (the beam angle performance for the CFLi-R is low) compared to the halogen lamps. Improvement of the performance plus the rate of price reduction will determine the development in the shift.

Within the halogen market, there is a trend of a market shift from HL-LV (12 V) to HL-MV (230 V), mainly because the installation work is easier without a transformer. This is documented by ELC sales in Table 2.6 and Table 2.7 showing a larger increase in low wattage HL-MV sales. Domestic customers in Belgium, Italy and UK already have a high stock of HL-MV-R lamps.

The above BAU forecast includes therefore increases in halogen lamp sales of 9.3%/year for HL-MV and 1.4%/year for HL-LV for the period 2007-2020.

The Light&Building 2008 fair in Frankfurt, newsletters and other exhibitions show that both European and Asian manufacturers are very inventive at a very high speed concerning LED-R and CFLi-R.

The number of luminaires is growing as the number of lamps is growing. Besides this trend, the use life time of the luminaires seems primarily to depend on changes in fashion. Technically there is nearly no limitation on the life time of a luminaire; they can even be found in antique shops.

Domestic lighting purchase process by the DIY customers

The current domestic lighting purchase process mainly takes place in the retail market. The customer buys luminaires and lighting sources in lamp shops, furniture stores (e.g. IKEA), building market/do-it-yourself shops and supermarkets. A questionnaire concerning the availability of reflector lamps in different shops was sent to the partners in the EU R&D projects Enerlin and REMODECE. The answers are shown in

Table 2.17.

[14] Comment by Auer Lighting.

Table 2.17: Where can the user buy reflector lamps?

			GLS				Halogen reflector Low Volt.								Halogen reflector MV								CFLi reflector lamps							
EU region	Country	Number of house	GLS Reflector				GU4 + GU5.3				G53				E14, E27, B14d, B22d				GU10, GZ10				E14, E27, B14d, B22d				GU10, GZ10			
		millions	LS	IK	BM	SM	LS	IK	BM	SM	LS	IK	BM	SM	LS	IK	BM	SM	LS	IK	BM	SM	LS	IK	BM	SM	LS	IK	BM	SM
Central and Eastern EU	BG	3,7	1				1				1				1				1				1	0	0	0	1	0	0	0
	CZ	4,40	1	1	1	1	1	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
	CY	0,32																												
	EE	0,60																												
	HU	4,10																												
	LV	0,97	1	1	1	1	1	0	1	1	1	0	0	0	1	0	1	0	1	1	1	0	1	0	1	0	1	0	1	0
	LT	1,30																												
	MT	0,13																												
	PL	13,30	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1
	RO	8,13	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	SK	2,10																												
	SI	0,69																												
Middle EU	AT	3,30																												
	BE	4,30	1			0	1	1	1	1					1			0	1		1	0	1			0	1		0	0
	FR	32,20																												
	DE	39,10	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0
	EI	1,44																												
	LU	0,20																												
	NL	7,00																												
	UK	26,20																												
Northern EU	DK	2,50	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	0	1	0	0	0
	FIN	2,50																												
	SE	4,50																												
Southern EU	GR	3,70	1	1	1	1	1	1	1	1					1	1	1	1					1			0	1	0	0	0
	IT	22,50	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	1	0	0	0	1	0	0	0
	PT	4,20	1	1	0	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1
	ES	17,20																												
TOTAL			11	8	8	7	11	8	9	10	9	2	1	1	11	6	7	5	10	6	6	5	10	3	3	1	9	2	3	2
			LS = lamp Shop																											
			IK = IKEA or similar																											
			BM = Building Market																											
			SM = Supermarkets																											

Table 2.17 shows:

- Nearly all reflector lamps are available in lamp shops,
- GLS-R is available in most shops,
- HL-LV-R (GU4 and GU5.3 cap type) is available in most shops,
- HL-MV-R is available in 50% of the shops,
- CFLi-R is currently only available in 25% of the shops.

LED-R was not included in the questionnaire since the product is not yet available in many consumer shops. Concerning the future shift to more energy efficient lighting, it is important that CFLi-R and LED-R solutions become available in all shops along with awareness campaigns.

The consumer seems to buy his luminaires primarily in DIY shops and installs the luminaires himself. In cases where light distribution matters and consumers rely on DIY shops they simply purchase luminaires for reflector lamps that can be oriented (these statements are impressions from discussion of these topics with people involved in this business).

Domestic lighting purchase process by professionals

A smaller amount of luminaires (in some countries like Italy a larger amount) is bought from architectural lighting manufacturers and is installed by professionals upon the specification of a lighting designer or architect. Some manufacturers of architectural lighting provide the photometric data that can be used in software simulation tools (see lot 8 and 9).

With growing welfare, many people are installing new kitchens, bathrooms or are adding verandas to their home. In this process, the designers, home decorators, installers or qualified electricians have a large influence by including lighting solutions in their projects. Many furniture and appliance manufacturers are even including lighting in their products, and this market seems to be dominated by halogen, down lighting reflector lamps. From 1995 until 2007, this has caused a shift from few GLS to a multitude of halogen lamps as can be seen in section 2.2.2 and Table 2.10. It has become fashionable to use a number of halogen reflector lamps in down lights for general illumination of kitchen, bathroom, corridor, hall, bed room and even living room. Typically 35W or 50W, 24 degree HL-LV or HL-MV are used. In several of these places, the directional light is inadequate to provide enough general lighting and therefore additional lighting might be added. Dimmers are also frequently used to be able to reduce the light output from down lighters that can cause discomfort glare.

The professionals often install ceiling and wall fittings/luminaires as a part of their installation work.

Global lighting production market

The global lighting-product manufacturing industry is made up of many enterprises ranging from large multinational private companies that manufacture a broad range of lighting products to small single-product firms publicly or privately owned. (IEA, 2006).

When viewed as a region, the European Union is the world's largest producer of lighting equipment in terms of value, although China is about to surpass the EU in terms of volume (IEA, 2006). The European lighting manufacturing industry has annual revenues of about EUR 13 billion, of which EUR 5 billion (USD 6.2 billion) originates from lamp manufacturers (ELC, 2005 in IEA, 2006) and EUR 8 billion from luminaires, ballasts and associated electrotechnical equipments (CELMA, 2005 in IEA, 2006).

Lamp manufacturers are represented by the European Lamp Companies Federation (ELC), which includes among its members Philips Lighting, OSRAM, GE Lighting, Aura Lighting Group, BLV, Leuci, Narva and Sylvania Lighting International (SLI). The European activities of these companies employs roughly 50,000 people and produces annual revenues of EUR 5 billion[15] (IEA, 2006). ELC claims to represent 95% of the total European lamp production but their part of the sales is much smaller as a considerable part e.g. of the CFLi sales is covered by retailers that import directly from China.

Manufacturers of luminaires and electrotechnical parts for luminaires are represented by CELMA. The 16 national member associations of CELMA represent some 1,200 companies in 11 European countries. These producers, which include many SMEs, directly employ some 100,000 people and

[15] http://www.elcfed.org/index.php?mode=0

generate EUR 8 billion annually. CELMA claims to supply more than 90% of luminaires and associated electrotechnical parts for the EU market (IEA, 2006).

Market shares and competition

Lamps are a globally traded commodity and there is a high degree of standardisation between international lighting markets. The lamp market is highly concentrated, with a limited amount of players and thus financial power in the marketplace, whereas the luminaire market is very fragmented.

For several decades four major multinational lamp manufacturers have dominated the international lamp market:

- Philips, based in the Netherlands
- OSRAM, based in Germany (also present in the United States as Sylvania)
- General Electric, based in the United States.
- Sylvania, based in Europe, recently renamed Havells Sylvania.

While these companies have a strong presence in almost all global markets, their strength appreciably varies in the different sectors and regions (IEA, 2006).

Shifts to a higher degree of use of CFLi-R and LED-R will result in a large import of lighting products from China.

According to Eurostat data for 2007, the EU-27 Member States with the largest luminaire production market share are:

- Italy 21%
- Germany 11%
- Spain 11%
- UK 7%
- France 5%.

Remark: Not all country data are available at Eurostat because some countries have classified them as confidential while other country data are not available and are estimated by Eurostat.

2.3.2 Duration of redesign cycle and market lifetime of the EuP

For these aspects, domestic lighting products are discussed as consisting of two essential parts:

- the light source, in some cases including its control gear,
- the luminaire as a holder for lamp and control gear.

Both parts have different redesign cycles and different market lifetimes.

2.3.2.1 Redesign cycle for a light source

The duration of a redesign cycle for a light source depends mainly on technology and it can last from several months to more than 50 years from first idea to functioning technology and working prototype. The redesign cycle will always include the long term reliability testing.

If it is only a question of amelioration of known, patent free technology, the main factor is lifetime testing: the maximum number of possible burning hours per year is about 8.000. A conversion of the production lines with possible investment decisions can extend this period.
Manufacturers are continuously working on ameliorating their products in such a way that the new product can replace the old one, without changing luminaire or control gear.

For example the low voltage, pin based halogen lamp was introduced in the seventies of the previous century and pleased the designers and customers by its bright, small appearance. Infrared reflecting coating in lamp production was already applied in low pressure sodium lamps in the beginning of the years 1980. It took about a decade to introduce this technology in the low voltage halogen lamps production; the results in energy savings are significant (for more information see chapter 6).

A similar example is the compact fluorescent lamp with integrated ballast that was globally introduced in the early 1980's and which is still continuously being ameliorated to replace a (frosted) incandescent lamp. The first lamp was fairly large and heavy with magnetic ballast and low R_a. New lamps are smaller, have lightweight electronic control gear, a colour rendering $80<R_a<90$ and finger, spiral or GLS look-alike forms (see chapter 6).

The LED is an example of an important technology change. The light emitting diode was invented in 1907.Research was discontinued because the light yields were extremely low, but in 1962 a team from GE demonstrated the first LED. 6 years later LEDs were first commercialised and used as red-light indicator lamps and electronic displays. Very bright red, yellow and green LEDs were produced in the 1980s. In the mid-1990s blue LEDs were developed. During the next years this led to development of WLED and its introduction as a 'general' light source[16].

2.3.2.2 Redesign cycle for a luminaire

A luminaire for domestic lighting is mostly intended to hold the light source and its possible control gear and to embellish the 'home environment'. The redesign cycle depends on the technological changes of light sources, fashion, the creativity of the designer and the production cycle. Changing production lines, finishing up available stocks of spare parts and new purchase contracts are the most influencing parameters. This cycle can be short e.g. some months after a decision or after the introduction of a new light source.

2.3.2.3 Market lifetime of a light source

It is not always easy to determine the market lifetime of a light source and its possible control gear. A clear example of a long market lifetime is the incandescent lamp that was invented in 1879.
After its introduction on the market (almost 130 years ago), various improvements were performed: the carbon wire was replaced by a tungsten wire, the vacuous bulb was first filled with an inert gas such as nitrogen and later in some cases with argon or krypton.

Also the halogen lamp is a special type of incandescent lamp where the filling gas contains halogen or xenon. The first halogen lamps came on the market in the years 1960 in the known form with R7s-cap. It was introduced originally for its improvement in lamp lumen maintenance, and was later recognised for its ability to improve lifetime and efficacy.

[16] The history of LEDs is a short summary of the description in Light's Labour's Lost, IEA, 2006

The smaller size low voltage halogen lamp that was introduced in the years 1970 stays on the market, although a better technology, the infrared coating, is available on the market. The end of the product life of the non-IRC halogen lamps will mainly depend on retail price and sufficient availability on the market; the fact that these new IRC-lamps are more energy-efficient doesn't seem to influence the consumers so much when the price stays high.

For CFLi's, the market lifetime is dependent on the meaning of 'product'. The first generation of compact fluorescent lamps can be considered a different product from the current CFLi's. These first generation lamps have even completely disappeared from the European market due to the better quality, shape and price of the new generation. At this time, the new generation lamps are being continuously ameliorated, but basically the product has not changed. It is very difficult to determine a product's market lifetime as the 'product' itself is not clearly determined.

It might be reasonable to operate with a market lifetime of maximum 20 years for any product.

2.3.2.4 Market lifetime of a luminaire

For the market lifetime of a luminaire (the period during which a luminaire is available for sale), a subdivision has to be made between:

- Classic, highly fashinable or traditional luminaires like crystal luminaires, bronze luminaires etc.
- Design, trendy and low price luminaires.

For the first small category, the market lifetime does not expire; manufacturers will only change details, but the basic model almost lasts for 'eternity'. The second and largest category, that is fashion dependent, has rarely more than a maximum market lifetime of 3 years as lighting designers like to renew their products as frequent as possible to be trendy.

For some special applications such as Christmas lights, the market lifetime can even be only one season, especially nowadays that LED's are entering the market for this purpose.

As a consequence, a uniform lifetime for domestic luminaires can hardly be given. A weighted average market lifetime of a luminaire of 3-4 years can be assumed.

2.4 Consumer expenditure data

2.4.1 Product prices

Eurostat data are not suitable for estimating product prices (luminaires, lamps, ballasts, other replacement parts). For product prices, we therefore used manufacturers' catalogues. Taking into account that the prices displayed in these catalogues are for retail trade, realistic assumptions for the prices of different lighting parts were made based on the experience of the market, e.g. consultation of small and large retailers, advertising brochures etc.

Chapter 4 gives specific retail prices for domestically used DLS lamps are; that prices can also be found in Table 2.18.

Table 2.18: Typical EU-27 retail prices for DLS lamps for domestic use

Lamp type	Lamp specification and cap	Price in €
GLS-R	R63, E27 (B22d)	1.3
HL-MV-R	R63, E27 (B22d), xenon	3
	PAR20, E27 (B22d)	13
	PAR20, E27 (B22d), IRC+TRAFO	26
	MR16, GU10	3
	MR16, GU10, xenon	7.5
HL-LV-R	MR16, 12V, GU5,3	1.5
	MR16, 12V, GU5,3, IRC	7
	R111, 12V, G53	9
	R111, 12V, G53, IRC	12
CFLi-R	R50, GU10	8
	R63, E27 (B22d)	8

Product prices for lamps can also include taxes or recycling contributions that can differ from country to country, some examples are included hereafter.

Denmark has taxation on lighting sources added to the sales price:

- CFLi no tax
- GLS 3.75 DKK (= 0.5 Euro)
- Fluorescent tube 7.5 DKK (= 1 Euro)
- Halogen low voltage 0.75 DKK (0.1 Euro)
- Halogen 230V 3.75 DKK (= 0.5 Euro)
- Metal halogen 7.5 DKK (= 1 Euro)
- Emission lamp 7.5 DKK (= 1 Euro)

The Danish taxation is basically a tax to collect state income but also an energy efficiency effort since there is no tax on CFLi's - nevertheless there is a tax for fluorescent tubes and metal halide lamps although these lamps are very energy efficient.

According to a decree-law of April 12, 2007 *Portugal* has such an added cost or 'tax' for low energy efficiency lamps to compensate for environmental influence from this type of lighting. The tax is calculated based on the following parameters: electric power and life cycle of the lamp compared to energy efficient lamps and the average value of CO_2 emission factor and cost for Portugal. The tax income will feed the Portuguese Fund for Carbon (80%) and the Energy Efficiency Fund (20%).

Several countries have an added 'disposal/recycling' contribution that is included in the sales price. For example *Belgium* has a WEEE directive specifying that a cost is added to the sales price for recycling. It is not a tax since it is not raised by the government but a contribution to take care of

the recycling. The cost per lamp is at present € 0.30 and is added for CFL, LFL and other discharge lamps while there is no cost for GLS and HL. For more information on recycling schemes and costs in other EU-27 countries please consult www.weee-forum.org.

For luminaires, production costs and used materials vary greatly and are almost only dependent on decorative aspects. The luminaire market price variation is from 4 to 2000 €. For more information about luminaire prices please see chapter 4. In line with the system approach explained in chapter 1 only the minimum extra cost (if any) will be taken into account in this study.

2.4.2 Electricity rates

Electricity costs account for an important part in the domestic lighting costs: according to IEA[17] lighting amounts up to 79% of the total cost. Electricity rates (euro/kWh) are subject to fluctuations due to recent market liberalisation.

Eurostat regularly reports on electricity prices for domestic household consumers are shown in Table 2.19 below.

[17] Source: IEA, 2006

Table 2.19: Electricity prices for domestic customers18

EU region	Country	Number of households	Electricity price for hh customers using 3500 kWh/year
		millions	€/kWh by 1/1 2007
Central and Eastern EU	Bulgaria (BL)	3.7	0.0658
	Czech Republic (CZ)	4.4	0.1067
	Cyprus (CY)	0.3	0.0796
	Estonia (EE)	0.6	0.075
	Hungary (HU)	4.1	0.1222
	Latvia (LV)	1.0	0.0686
	Lithuania (LT)	1.3	0.0777
	Malta (MT)	0.1	0.0895
	Poland (PL)	13.3	0.1184
	Rumania (RO)	8.1	0.1018
	Slovenia (SK)	2.1	0.1537
	Slovakia (SI)	0.7	0.1064
Middle EU	Austria (AT)	3.3	0.1545
	Belgium (BE)	4.3	0.1581
	France (FR)	32.2	0.1211
	Germany (DE)	39.1	0.1949
	Ireland (IE)	1.4	0.1662
	Luxembourg (LU)	0.2	0.1684
	The Netherlands (NL)	7.0	0.218
	United Kingdom (UK)	26.2	0.1323
Northern EU	Denmark (DK)	2.5	0.258
	Finland (FI)	2.5	0.116
	Sweden (SE)	4.5	0.1714
Southern EU	Greece (EL)	3.7	0.072
	Italy (IT)	22.5	0.2329
	Portugal (PT)	4.2	0.15
	Spain (ES)	17.2	0.1225
EU27 average (weighted by hh)		**210.6**	**0.1529**

2.4.3 Repair, maintenance and installation costs

Lamps are currently considered as replacement parts for luminaires because lamp lifetime is typically shorter than the luminaire lifetime. LED's lamps that last as long as the luminaire change this point. The LED technology is considered in chapter 6.

Domestic customers are typically doing installation, maintenance and shift of lamps and luminaries themselves but are often not able to do maintenance/shift of more complicated outdoor or ceiling luminaries installed by professionals when building or rebuilding the home.

Many people are installing new kitchens, bathrooms or are adding verandas where installation of new luminaries is an integral part of the rebuilding. In this case, it is not necessary to include installation costs as the customer is doing this rebuilding anyway and it is part of a total package.

[18] Eurostat collects regularly data for 5 categories of domestic consumption, ranging between annual consumption 600 kWh to 20,000 kWh. Here is used "medium size household" (3,500 kWh/year)

Replacement of lamps is mostly done by the domestic user and hence no labor cost will be taken into account. Repair, maintenance of replacement of luminaires, are typically also done by the domestic user but for some ceiling and outdoor luminaires installed during the construction, the replacement might be so difficult that the customer needs to hire a professional to do this; in that case the cost might be very high and is thus unpredictable.

The replacement of luminaires is sometimes done by a professional installer, frequently in combination with other construction or renovation work (e.g. new kitchen installation). A UK market research report on domestic lighting[19] showed that 39% of the domestic luminaires (especially ceiling mounted and outdoor) were installed by qualified electricians. Hence in some cases installation costs for luminaires should be taken into account.

For improvement options in later chapters no installation or maintenance costs were taken into consideration when the luminaires are not supposed to be replaced before their end of life.
For improvement options where a professional installer is absolutely required to replace a luminaire, the average hourly labour cost of €21.22, representative for EU25 (source Eurostat, data for 2004). As this cost is five years old, an updated average hourly labour cost of €25 is used.

- Hourly labour cost = €25

2.4.4 Interest and inflation rate

EU-27 averages for interest rate and inflation rate are published by ECB and Eurostat:

- Interest rate = 3.9 % (source ECB[20])
- The Inflation rate was 2.1 % (source Eurostat[21]) in 2007 at the start of this study. Since then, the inflation rate has risen up to 4 % and returned back down to 2 %. Under the present circumstances, it is very hard to forecast the inflation rate.

Please note that these values can vary on a monthly basis and are related to currency (Euro-zone and outside Euro-zone member states).

[19] Domestic Lighting Report, Lighting Association, UK, 2008.
[20] ECB long-term interest rate; 10-year government bond yields, secondary market. Annual average (%), 2005
[21] EU-27 Annual Inflation (%) in Dec 2005 Eurostat "Euro-Indicators", 7/2006 - 19 January 2006.

3 CONSUMER BEHAVIOUR AND LOCAL INFRASTRUCTURE

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4 TECHNICAL ANALYSIS EXISTING PRODUCTS

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5 DEFINITION OF BASE-CASE

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6 TECHNICAL ANALYSIS BAT

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